DIOXIN MONITORING PROGRAM

(Including data on Dioxin-like PCBs collected in the Surface Water Ambient Toxics Monitoring Program)

2005

REPORT

DEPARTMENT OF ENVIRONMENTAL PROTECTION
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OVERVIEW

This report contains the findings from the 2005 Dioxin Monitoring Program with respect to the three primary goals of the program:

1. assessment of the nature and extent of dioxin contamination in waters and fisheries of the state and its effect on human health,
2. evaluation of trends, and
3. measurement of compliance with the no discharge of dioxin provision of the 1997 Dioxin Law via the above/below (A/B) fish test for the remaining kraft pulp & paper mill still in the program.

The figures in this report also contain the (dioxin-like) coplanar PCB data gathered as part of DEP's Surface Water Ambient Toxics (SWAT) monitoring program. Coplanar PCB data are included in order to show the total exposure to dioxin-like compounds from consumption of certain fish from several Maine rivers in order for the Maine Center for Disease Control to make a complete assessment of the fish consumption advisories. The coplanar PCB data are distinct from the dioxin data and the reporting requirements of the Above/Below test. Sources of the coplanar PCBs are not known, but likely include historic use and discharge in Maine and long range transport and atmospheric deposition.

HUMAN HEALTH FINDINGS

- There are Fish Consumption Advisories for the **Androscoggin**, **Kennebec**, **Penobscot**, **Sebasticook**, and **Salmon Falls Rivers**, due to dioxins or a combination of dioxins and dioxin-like coplanar PCBs. These advisories are more restrictive than the statewide mercury advisory.

- An evaluation of the health implications of dioxin/furan concentrations in fish in Maine Rivers requires a comparison to a health benchmark. The Bureau of Health uses a health benchmark that is expressed as a specific fish tissue concentration of dioxins and furans, referred to as a "Fish Tissue Action Level" or FTAL[1]. For the present report, the Bureau compares the most recent data on dioxins and furan levels in fish tissue to its current FTALc of 1.5 parts per trillion (ppt) for protection of cancer-related effects. The Bureau also compares dioxin, furans, and coplanar PCB levels to its FTALr of 1.8 parts per ppt for protection of noncancer or reproductive related effects. The Bureau additionally compares all data to a lower pFTALc of 0.4 ppt , which is under consideration as a potential revision to current FTALs, to account for background dietary exposure to dioxins and furans.

- Concentrations of dioxins and furans in bass tissue at all sampling locations above and below Maine pulp and paper mills were below the current FTALc of 1.5 ppt (Figure 1). Concentrations in white suckers on the Androscoggin River exceeded the FTALc but concentrations in white suckers on the Kennebec and Penobscot rivers were below the FTALc (Figure 2). Concentrations in rainbow trout in Gilead, Maine, above the Maine mills but downstream of the bleached kraft mill in Berlin, NH, were right at the FTALc.

[1] See page 10 for definitions

- Concentrations of dioxins and furans in both species at all sampling locations on the Androscoggin River were above the pFTALc of 0.4 ppt. Concentrations in both bass and suckers on the Kennebec River were below the pFTALc as were the concentrations for bass on the Penobscot River.

- When the concentrations of dioxin-like coplanar PCBs were added to the dioxin concentrations, there were exceedances for the current FTALr of 1.8 ppt in rainbow trout at Gilead on the Androscoggin River, in suckers at Riley and Livermore Falls on the Androscoggin River, and at Lincoln on the Penobscot River. These data were collected in the Surface Water Ambient Toxics (SWAT) monitoring program. Sources are unknown but likely include historic use and discharge in Maine and long-range transport and atmospheric deposition.

- Average dioxin and furan levels in Androscoggin Lake have not been reported above the current FTALc of 1.5 ppt in any species since 1996, although addition of coplanar PCBs resulted in exceedance in white perch and a near exceedance in smallmouth bass (Figure 1). Concentrations of dioxins and furans in white perch exceeded the pFTALc of 0.4 ppt, but concentrations in bass did not.

- Dioxin concentrations in bass from the West Branch of the Sebasticook River in Palmyra were at the pFTALc. Dioxin concentrations in bass from the main stem at Burnham are lower than the FTALc, but exceed the pFTALc of 0.4 ppt.

Figure 1. Dioxin (DTEh95ucl) and coplanar PCB (CTEh95ucl) toxic equivalents in smallmouth bass (and white perch WHP, brown trout BNT and rainbow trout RBT) from the Androscoggin (Axy), Kennebec (Kxy), Penobscot (Pxy) and Sebasticook (Sxy) rivers, 2005

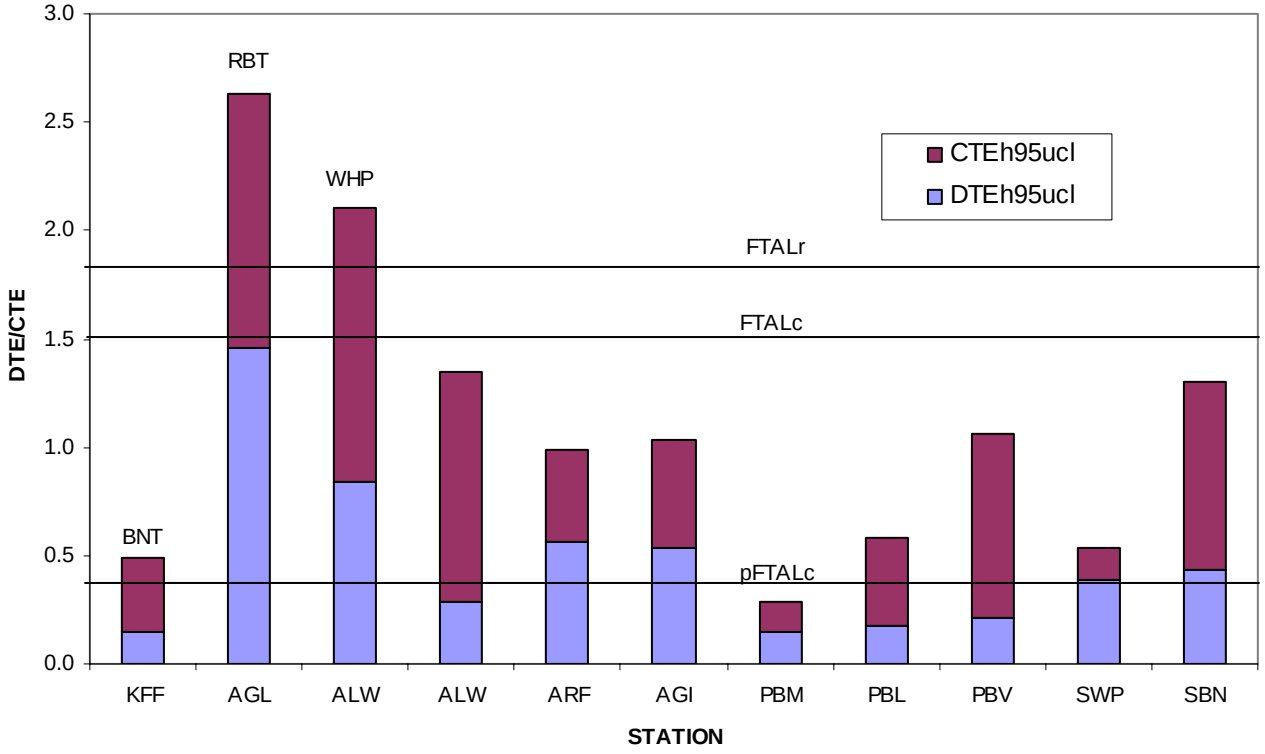
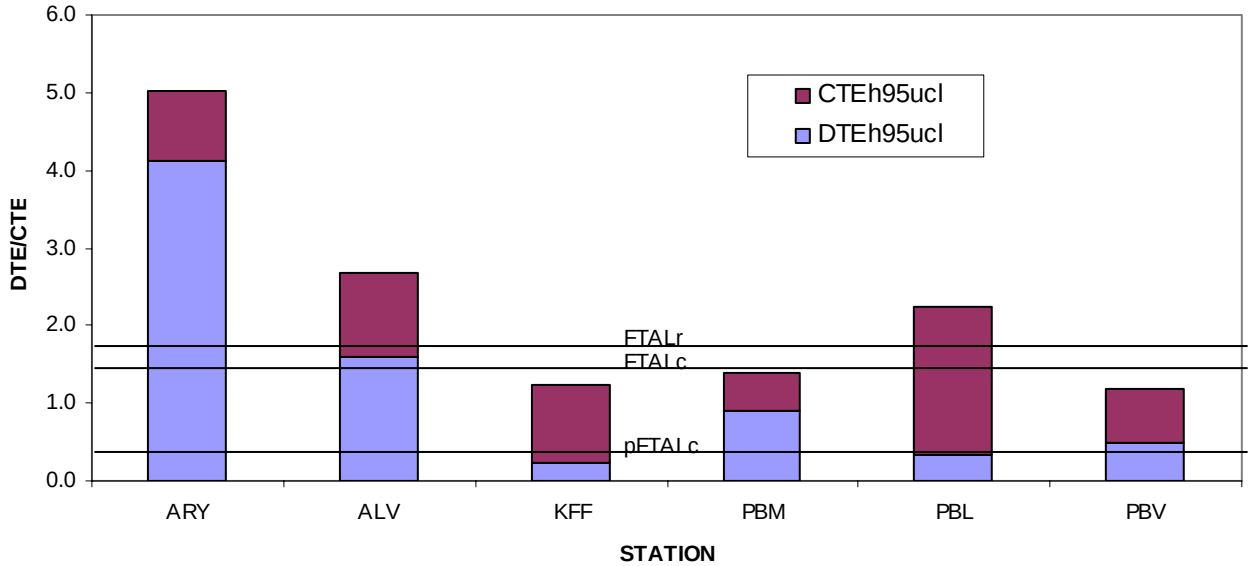


Figure 2. 2005 dioxin (DTEh95ucl) and 2001 coplanar PCB (CTEh95ucl) toxic equivalents in white suckers from the Androscoggin (Axy), Kennebec (Kxy), and Penobscot (Pxy) rivers, 2005



FINDINGS ON DISCHARGES FROM BLEACHED KRAFT PULP AND PAPER MILLS

- Results of the Above/Below (A/B) test had indicated by 2004 that there was no longer a discharge of dioxin from the NewPage mill in Rumford, the International Paper mill in Jay, the SAPPI-Somerset mill in Skowhegan, or the Georgia-Pacific mill in Old Town. This left just the Lincoln Pulp and Tissue Mill in Lincoln needing to demonstrate compliance with the test.

- Due to unprecedented rainfall, caged mussels deployed in the Penobscot River as part of the Dioxin above/below (A/B) test for Lincoln Paper and Tissue could not be retrieved. Nevertheless, for the two fish species, there was no significant difference in concentrations of dioxins in either smallmouth bass or white suckers above and below the mill. This second year finding of no difference above and below the mill is evidence that the mill is no longer discharging significant amounts of dioxin. The mill therefore passes the A/B test.

- For those mills that have passed the A/B test previously, continued annual compliance with the no-discharge provision in 38 MRSA section 420 may be demonstrated by either of two methods. 1). Bleach plant effluent concentrations, monitored at least once per year and reported at the actual concentrations rather than the nominal 10 ppq limit, must remain as low as the years in which a mill demonstrated compliance with the A/B test. In addition, the mills must provide a dioxin/furan certification that the bleach plant and defoamers continue to be operated and used in a manner similar to that in 2003 and 2004. 2) Compliance may also be demonstrated by repeating the A/B fish test.

- Continued compliance in 2005 was demonstrated for the NewPage mill in Rumford (formerly MeadWestvaco), International Paper mill in Jay and SAPPI Somerset mill in Skowhegan by dioxin/furan certification of bleach plant operation and bleach plant effluent data. Continued compliance at Georgia Pacific was demonstrated by continuing low concentrations in the bleach plant effluent.

- Continued elevated levels above background at some locations below mills in these rivers may be the legacy of the long history of discharges to the rivers.

- The Dioxin Monitoring Program will need to be continued as currently specified by 38 MRSA § 420-A to monitor continuing elevated levels of dioxin in fish from some of these rivers for the Fish Consumption Advisories

BACKGROUND ON DIOXIN

Due to continuing controversy over the effects of dioxin on human and ecological health, the US Environmental Protection Agency (EPA) announced in 1991 it would begin a thorough scientific reassessment of dioxin. EPA proposed that the process would be open to the public and consequently held several meetings to share information and receive comments. A draft report was issued in 1994 and subsequent review in 1995 by EPA's Science Advisory Board called for revisions of some chapters. Revised drafts published in 2000 indicate that dioxin may exhibit reproductive and developmental effects, immuno-toxic effects, neuro-toxic effects, and cancer. In addition, the report found that concentrations of dioxin in the environment have decreased since the 1970s. Also 'EPA currently estimates that the amount of dioxin in tissues of the general human population closely approaches, within a factor of 10, the levels at which adverse effects might be expected to occur'. In March 2001 EPA's Scientific Advisory Board published its draft review of EPA's new revisions and is divided on whether or not dioxin is a carcinogen, but does believe EPA has underestimated non-cancer effects. The Scientific Advisory Board also does not agree that there is enough evidence to support EPA's statement about current body burdens and probable adverse health impacts.

DIOXIN MONITORING PROGRAM

Dioxin was first discovered to be a problem in Maine in 1985, when the results of an analysis of fish collected in 1984 from the Androscoggin River by the Maine Department of Environmental Protection (the Department), used as a reference station for EPA's National Dioxin Study, documented significant concentrations of dioxin. Consequently, the Maine Bureau of Health issued Maine's first fish consumption advisory in 1985. Additional sampling in 1985 and 1986 found similar levels in fish from other rivers below bleached kraft pulp and paper mills, but not from rivers or lakes without such sources. This led to including parts of the Kennebec River and Penobscot River in a revised fish consumption advisory in 1987. As a result there was a bill before the Maine legislature in 1988 to ban the discharge of dioxin, but the bill was amended to establish a monitoring program, Maine's Dioxin Monitoring Program (DMP) and enacted into law (38 MRSA section 420-A) to sunset in 1990. Discovery of continuing significant concentrations in fish from these and other rivers resulted in the DMP being reauthorized in 1990, 1995, 1997, and most recently in 2002 extending until 2007. The Department has issued reports of the results of monitoring annually. Fish consumption advisories have been issued or modified in 1985, 1987, 1990, 1992, 1994, 1997, and 2000.

The goal of Maine's Dioxin Monitoring Program is "to determine the nature of dioxin contamination in the waters and fisheries of the State". Charged with administration of the program, the Department is required to sample fish once a year below no more than 12 bleached pulp mills, municipal wastewater treatment plants, or other known or likely sources of dioxin. Costs for equipment, supplies, and analysis are assessed to the selected facilities annually, and could not exceed $168,000 until 1997 when the limit was raised to $250,000 to incorporate development of the Above/Below (A/B) fish test.

The Department is advised by the Surface Water Ambient Toxic (SWAT) Monitoring Program Technical Advisory Group in implementation of the program. An annual report is required to be submitted to the Natural Resources Committee of the Maine Legislature by March 31 with the results

from the previous year, including status of progress toward meeting the requirements of the Dioxin/Color law.

The primary objective of the Dioxin Monitoring Program is to monitor dioxin in fish for assessment of human health and ecological impact.

A second objective is to measure trends, progress toward reduction in environmental concentrations, and effectiveness and need for further controls.

The monitoring program is coordinated with other ongoing programs conducted by the Department, US Environmental Protection Agency (EPA), or dischargers of wastewater. The proposed annual monitoring plan must be submitted to the Surface Water Ambient Toxic (SWAT) monitoring program Technical Advisory Group (TAG), created under 38 MRSA section 420-B, for review and advice. The selected facilities must be notified of their inclusion in the proposed program at least 30 days prior to submittal to the TAG. The Department must incorporate the results of all studies into a report due the Natural Resources Committee by March 31 of the following year. A draft of the report is reviewed by the TAG before completion of the final report. Costs of sample collection and analysis are assessed as a fee to the selected facilities. Payment of the fees is a condition of the waste discharge license granted by the State for continued operation and discharge of wastewater to waters of the State. However, if the selected facility is a publicly owned treatment works (POTW), then the fees may be assessed to the known or likely industrial generator of dioxin, and payment will not be a condition of the waste discharge license of the POTW.

1997 DIOXIN/COLOR LAW

A third objective, integrated into the DMP, comes from the Dioxin/Color law. In 1997 the Maine Legislature enacted LD 1633 "An Act to Make Fish in Maine Rivers Safe to Eat and Reduce Color Pollution", the Dioxin/Color law [38 MRSA section 420(2)(I)]. The key requirement is that ‘a (bleach kraft pulp) mill may not discharge dioxin into its receiving waters after December 31, 2002. To determine compliance, there are interim tests and a final test. Two interim tests, of effluent from the bleach plant require that 1) TCDD (2378-tetrachlorodibenzo-p-dioxin, the most toxic of the 17 toxic dioxins and furans) must be below 10 ppq, parts per quadrillion or picograms per gram, pg/g by July 31, 1998 and 2) TCDF (2378-tetrachlorodibenzofuran) must be below the same detection limit by December 31, 1999. As the final test to confirm that there is no discharge, by December 31, 2002 fish (or surrogate) below a bleached kraft pulp mill must have no more dioxin than fish (or surrogate) above the mill, the so-called "above/below (A/B) fish test".

Since contamination levels in fish are likely to be highest in late summer to early fall, sampling for compliance with the December 31, 2002, deadline could not begin until summer 2003. Because laboratory results of summer data are not available in time to report by December 31 of any given year, the legislature amended the 1997 Dioxin/Color law in 2003 to delay the date of DEP’s report by a year, to February 16, 2004. The amendment also delayed the date by which a mill must demonstrate it no longer discharges, if the Department finds that it does, for a year after that. The amendment also requires the mills to make the demonstration annually. Additional legislation has combined reporting of compliance with the law with the annual Dioxin Monitoring Program report due March 31 of the year following data collection.

ABOVE/BELOW (A/B) TEST

DEP's report 'Dioxin Monitoring Program 2002-2003, Status of Dioxin in Maine's Rivers' dated February 25, 2004 established the A/B test as follows:

1) The test will measure contaminant concentrations in 3 separate species: a) bass b) suckers, and c) caged mussels.

2) A preponderance of evidence (POE) approach will be used where passage of 2 of the 3 tests will be used to indicate no discharge.

3) To achieve an overall 95% confidence with the POE approach, the level of significance for each individual test is 0.135 for both type I and II errors.

4) Compounds to be measured will be 2378-TCDD and 2378-TCDF, combined into a single metric, TCDD + (TEF x TCDF), to equivalently weight both congeners.

5) Concentrations of these compounds will be based on lipid normalized values if there is a significant relationship between contaminant concentration and lipid from linear regression, or wet weight values if there is no significant correlation.

6) Concentrations less than the detection limit (<DL) will be calculated at ½ the DL.

7) Where all of the values for the samples at an above or below station are <DL, no statistical determination will be made.

8) To compensate for the sensitivity of the tests, a mill must show no evidence of a discharge for 2 consecutive years before being deemed in compliance. Once a mill has passed the A/B test, continued compliance may be demonstrated by annual (1/year) testing of the bleach plant effluent that shows concentrations are below 10 ppq and certification that the bleach plant operation meets the following criteria:

CRITERIA FOR CERTIFICATION OF BLEACH PLANT OPERATION

In lieu of 1/Month monitoring of the bleach plant waste stream for 2,3,7,8 TCDD (dioxin) and 2,3,7,8 TCDF (furan) (40 CFR Part 430), by December 31 of each calendar year *(PCS Code 95799),* the permittee shall sample (1/year) and report the results for said parameters and provide the Department with a certification stating:

a. Elemental chlorine gas or hypochlorite was not used in the bleaching of pulp.

b. The chlorine dioxide (ClO_2) generating plant has been operated in a manner which minimizes or eliminates byproduct elemental chlorine generation per the manufacturers/suppliers recommendations.

c. Documented and verifiable purchasing procedures are in place for the procurement of defoamers or other additives without elevated levels of known dioxin precursors.

d. Fundamental design changes that affect the ClO_2 plant and/or bleach plant operation have been reported to the Department prior to their implementation and said reports explained the reason(s) for the change and any possible adverse consequences.

FISH CONSUMPTION ADVISORIES

There is a statewide fish consumption advisory due to mercury for all fresh waters. There are additional advisories for a number of rivers due to dioxins and dioxin-like (coplanar) PCBs, other advisories due to total PCBs, and still other advisories due to DDTs (Appendix 1).

There are 75 dioxins and 135 related furans, 17 of which are considered toxic, but with different toxicities. The total toxicity of a sample (dioxin toxic equivalents=DTE or toxic equivalents=TEQ) can be calculated as the sum of the product of the concentration and toxicity equivalency factor (TEF, relative to the most toxic dioxin, TCDD) for each of the 17 dioxin and furans.

For informing the public about potential risk from consuming fish contaminated with dioxin and dioxin-like compounds, the Maine Bureau of Health (BOH) publishes fish consumption advisories. These advisories are based on a comparison of a Fish Tissue Action Level (FTAL) for dioxin toxic equivalent (DTE) concentrations with the 95^{th} percentile upper confidence limit on the mean DTE in fish tissue. Should a tissue concentration exceed an FTAL, a fish consumption rate (e.g., # meals per month), which is unlikely to result in deleterious effects, is determined. Two FTALs have been derived for evaluating potential deleterious effects from exposure to dioxins and dioxin-like compounds. Both FTALs were developed using standard USEPA risk assessment methods (EPA 1997). For potential carcinogenic effects associated with long-term exposure, BOH has developed a FTALc of 1.5 ppt, while for reproductive and developmental effects potentially arising from shorter exposure durations, BOH has developed a FTALr of 1.8 ppt (Frakes, 1990). The FTALr for reproductive and developmental effects is relevant to women of childbearing age, pregnant women, and lactating women. The FTALs are compared to the concentration of DTE in edible portions of the fish, skinless filet data. Where whole fish data are reported, the DTE concentration is divided by a factor of 3.5, determined from previous studies with white suckers, to estimate skinless filet concentration. In this report all comparisons with DTE in fish are made with FTALc, since that is the lower of the two and protective against both effects.

WORKPLAN DESIGN

The primary emphasis of the 2005 workplan was to collect fish samples from the appropriate stations and species from each river such that accurate, complete, and current data are available to assess impact to wildlife and human consumers. The workplan design included sampling at least one station below each major source to document trends and sampling of historic stations that showed dioxin above background whether or not any fish consumption advisories were issued. Finally the workplan was modified to evaluate the A/B test.

The 2005 workplan was initially drafted by DEP according to the objectives listed above and sent to participating facilities for comment in early May 2005. After discussion of the draft workplan at a meeting of the SWAT Technical Advisory Group (TAG) on June 9, 2005, a final workplan was determined by the Commissioner.

In 2005 all stations were to be monitored for ecological and/or human health assessment and trends. At least 5 game fish (bass or other important species) were to be collected from each station (Table 1). We were unable to capture brown trout of the right size from the Kennebec River at Sidney, nor eels from the Penobscot River in Bangor. White suckers were collected at several stations for use in both ecological and human health assessment. At some stations, the fish were analyzed individually, while at other stations, fish were combined into composite samples in order to minimize cost and remain under the monetary cap.

For the A/B test, the goal was to reduce the variability of results thereby decreasing the minimum significant difference (MSD) that could be detected statistically between the above and below stations. Decreasing the MSD increases the sensitivity and power of the A/B test. Two ways to reduce variability are to use composite samples instead of single fish and to use a large sample size. Given these objectives and realistic sampling effort and cost, the target was to collect 30 smallmouth bass and 30 white suckers at historical stations above and below Lincoln Paper and Tissue Company. The 30 fish were combined into 10 composites of 3 fish each (10C3). In addition, caged mussels were deployed at the same A/B stations as the fish sampling. The caged mussels in the Penobscot River were lost, however, during fall flooding just prior to scheduled retrieval.

All samples were analyzed for all 2378-substituted dioxins and furans. All fish were analyzed for human health as skinless filets.

The preferred sampling time is late in the summer when fish are likely to be most contaminated after being exposed to higher concentrations of dioxin during low river flows and after significant growth has occurred. At some locations there has been a problem collecting enough fish later in the summer. At those locations sampling began in mid-May to try to insure that a suitable sample was collected. These stations were also visited after the beginning of July if there was time. If fish were captured during the later period, those samples were submitted for analyses. Otherwise, the fish collected during the early period were used. Sampling at other stations began in July. Actual dates of collection are shown in Appendix 6.

Table 1. 2005 Dioxin Monitoring Program

STATION	BASS	SUCKER	MUSSELS	OTHER	FACILITY
Androscoggin R					
Rumford	5				NewPage
Riley		5			NewPage
Livermore Falls		5			International Paper
Turner (GIP)	5				International Paper
Androscoggin L	2C5			2C5 white perch	IP & NewPage
Kennebec R					
Fairfield		5		5 brown trout	SD Warren
Sidney				5 brown trout	KSTD
Penobscot R					
Woodville	10C3	10C3	10C10	3C10 T-0 mussels	Lincoln Paper & Tissue
S Lincoln	10C3	10C3	10C10		Lincoln Paper & Tissue
Veazie		5			Georgia Pacific
Bangor				5 eels	Georgia Pacific
Salmon Falls R					
S Berwick				4 sludge	Berwick Sewer Distict
W Br Sebasticook R					
Palmyra	5				Hartland

SAMPLING PROCEDURES

Fish were collected by DEP with assistance of state agencies and the Penobscot Indian Nation. Upon capture, fish were immediately killed, weighed and measured, rinsed in river water, wrapped in aluminum foil with the shiny side out, labeled, and placed in a cooler on ice for transport to the DEP lab. Chain-of-custody forms were used to record all field information and document all transfers. In the lab, all fish samples were frozen and later transported whole to the Pace Analytical Services lab in Minneapolis, Minnesota for analysis. All other procedures followed EPA's Sampling Guidance Manual for the National Dioxin Study (July 1984). A laboratory log was kept for an inventory of samples in the lab at any time and final disposition.

Most of the facilities in the program already sample sludge or effluent as part of their Maine Sludge Spreading Permit or Waste Discharge License or Federal NPDES permit. Data from those programs provide adequate information about sources of dioxin. Therefore, no additional sludge samples were collected as part of this program. Effluent data are also used when available to indicate sources and any trends.

CALCULATIONS

In this report, dioxins are reported in different ways for each goal of the program. Given the uncertainty of true values when results are below the detection level, for the purpose of determining the range of possible concentrations, DTE are shown as a range with non-detects calculated at zero (DTEo) and at the detection limit (DTEd) as a mean for all samples of a given species at each station (Appendix 7). For human health assessment, DTEh, calculated using non-detects at 1/2 the detection limit consistent with the policy of the Maine Center for Disease Control (MCDC, formerly Maine Bureau of Health) were compared with the FTALc. The upper 95^{th} percentile confidence limit (UCL) was used for these comparisons, consistent with the policy of the BOH. For the A/B test, TCDD and TCDF were used. Because raw values for TCDF are much larger than those for TCDD, and in order to give more equal influence to both, TCDF was converted to TCDD equivalents using its TEF. The TCDD equivalent was then added to the TCDD concentration, essentially calculating a TEQ or DTE for TCDD and TCDF only with non-detects at ½ the detection limit (DFTEh).

A related issue is that of estimated maximum possible concentrations (EMPC). Some compounds, particularly hydroxydiphenyl ethers (DPEs), are coextracted with furans. Various steps have successfully been taken to minimize these interferences, but some DPEs remain. In this report, EMPCs were treated as non-detects.

Statistical analyses of differences in DFTEh between stations were performed using either the t-test or non-parametric Mann-Whitney test.

RESULTS AND DISCUSSION.

Results for each sampling station are discussed with respect to the three objectives of the program, 1) human health, 2) trends, and 3) where pertinent, the no discharge provision (A/B test). See Appendix 2 for raw dioxin data for 2005, Appendix 6 for fish sample data, and Appendix 7 for all historical dioxin data.

Dioxin concentrations in fish generally continued to decline from previous years, but there is some year-to-year variation in the trends. Concentrations remained elevated above natural background levels in fish at some stations, particularly on the Androscoggin and Sebasticook rivers, but approached background levels at some stations on other rivers. Dioxin toxic equivalents (DTEh), most likely from historical discharges from the mills, exceeded or, combined with (dioxin-like) coplanar PCBs (CTEh) contributed significantly to exceedances of the Bureau of Health's Fish Tissue Action Levels (FTAL) at several stations (Figures 1 & 2). DTEh are compared to existing FTALc and potentially new pFTALc for the cancer endpoint. The sum of DTEh and CTEh are compared to the existing FTALr for the reproductive endpoint. CTEh, which are measured in the SWAT program, were measured in bass, white perch, brown trout and rainbow trout in 2005. CTEh data for suckers, which was not collected in 2005, are taken from the most recent year sampled, 2001. Sources of CTEh, measured in DEP's SWAT program, are unknown but likely include combustion with long range transport and atmospheric deposition from local, regional, and national sources. Details are discussed below for each station.

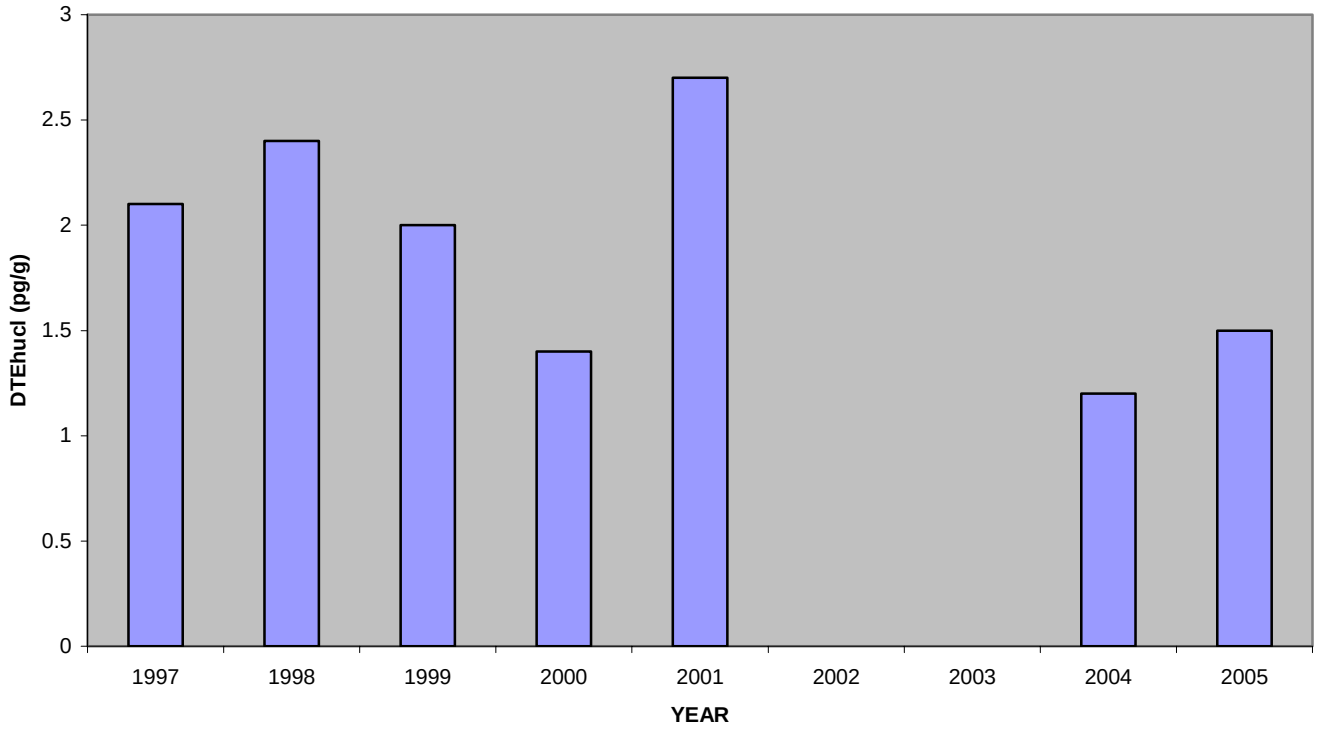
Androscoggin River

Gilead - (AGL) A total of 5 rainbow trout were collected near Peabody Island in Gilead (Appendix 6). This station is downstream of Fraser Paper Co's bleached kraft mill in Berlin, New Hampshire but upstream of all Maine mills.

DTEh concentrations were essentially at the FTALc and the highest of all fish species and stations in the state (Figure 1, Appendix 2). The addition of dioxin-like (coplanar) PCBs to DTEh results in even higher levels of total toxic equivalents (TTEh) that exceed the FTALr.

Every year measured, TCDD and DTEh in fish have been significantly higher at this station than in fish from reference stations in Maine (Appendix 7). There was no significant trend for the period 1997-2005 for rainbow trout or any other species captured at this station in the past, although concentrations of TCDD have decreased significantly in the past two years (Figure 3). The mill in Berlin, New Hampshire, has reported to have switched to elemental chlorine free (ECF) bleaching (chlorine dioxide) in 1994. The mill closed in 2001 but the paper and pulp mills were purchased by Fraser and reopened in 2002 and 2003 respectively.

Figure 3. Dioxin levels (DTEhucl) in rainbow trout from the Androscoggin River at Gilead Maine



Rumford - (ARF) A total of 5 smallmouth bass were collected from the river reach from just below the discharge from NewPage Corporation's bleached kraft pulp and paper mill in Rumford downstream about 4 miles to Dixfield (Appendix 6).

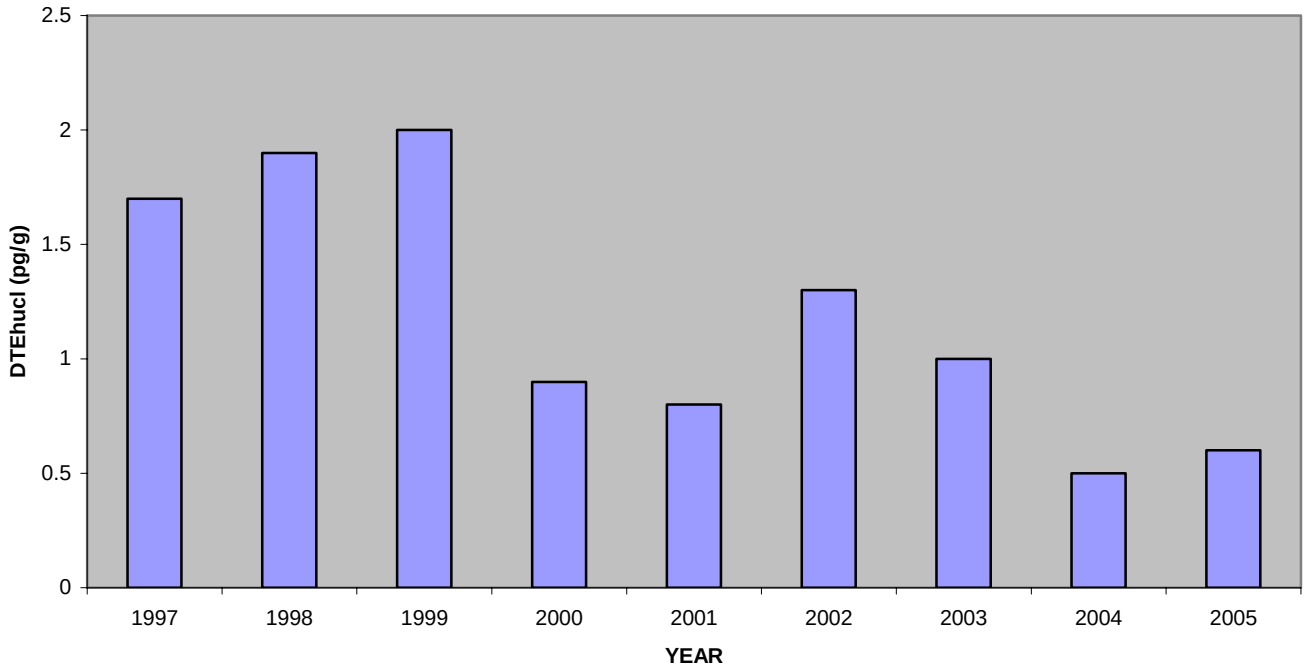
Concentrations of DTEh in the bass were 38% of the FTALc but exceeded the pFTALc (Figure 1, , Appendix 2). The addition of dioxin-like (coplanar) PCBs to DTEh results in higher levels of total toxic equivalents (TTEh**)** that were still below the FTALc.

There is a significant declining trend for TCDD and DTEo for bass during the period 1997-2005 (Figure 4). TCDD was no longer much greater than reference stations unimpacted by point source discharges on other Maine rivers but DTE is still elevated (Appendix 7). Continued elevated levels of DTE below the mill are likely the legacy of the long history of discharges. This fact warrants some continued monitoring for assessing the fish consumption advisories, and can also be used to document continuing compliance with the no discharge provision, all within the Dioxin Monitoring Program.

Fish sampling in 2003 and 2004 documented that the mill was no longer discharging measurable amounts of dioxins. In a letter dated December 28, 2005 the mill partially demonstrated continued compliance with the 'no discharge' provision of the 1997 Dioxin law by certifying that it has met the performance criteria established by DEP for the bleaching process and defoamer usage (Appendix 8).

An annual sample of the bleach plant effluent will be analyzed for dioxins within 1 year of issuance of the Maine Pollution Discharge Elimination System permit in September 2005. Concentrations of both TCDD and TCDF have been reported below variable detection levels in final effluent since 1993 and below a 10 ppq detection limit in bleach plant effluent since 1998 up through 2004, the latest that data are available (Appendix 4).

Figure 4. Dioxin levels (DTEhucl) in smallmouth bass from the Androscoggin River below Rumford

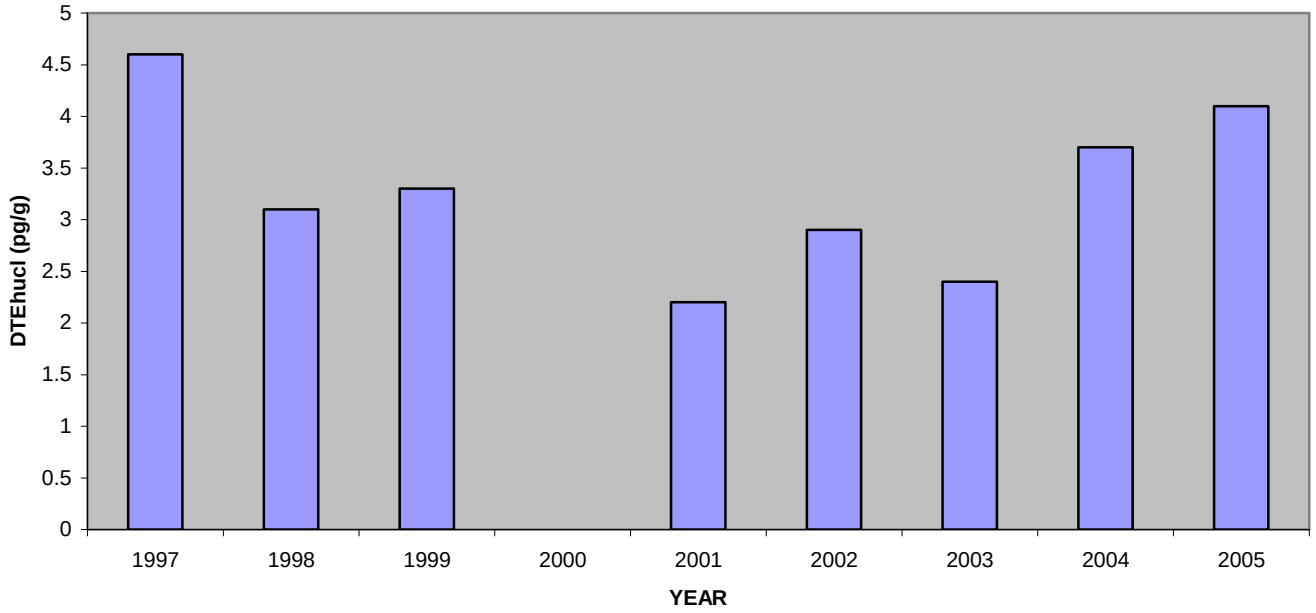


Riley - (ARY) A total of 5 white suckers were collected from the river above the Riley Dam about 19 miles downstream of NewPage Corporation and upstream of International Paper Company's discharge (Appendix 6).

Concentrations of DTEh in the suckers were 274% of the FTALc and exceed the FTALr (Figure 2, Appendix 2). The addition of dioxin-like (coplanar) PCBs to DTEh results in total toxic equivalents (TTEh) that further exceed the FTALr**.**

Unlike concentrations in bass at ARF, there is no trend of declining TCDD or DTEh concentrations in white suckers at Riley for the period 1997-2005 (Figure 5). Nevertheless, TCDD and DTEh concentrations continue to be greater than those at reference stations on other Maine rivers (Appendix 7). The fact that concentrations of dioxin in suckers have been historically higher here than upstream at ARF, in spite of the fact that there are no known or likely sources in between, may be due to the fact that

Figure 5. Dioxin levels (DTEhucl) in white suckers from the Androscoggin River at Riley, above Jay Maine



ARY is in an impoundment, a depositional area for settleable solids bound dioxin, whereas ARF is free-flowing, making ARY a better sampling location for detection of any contamination.

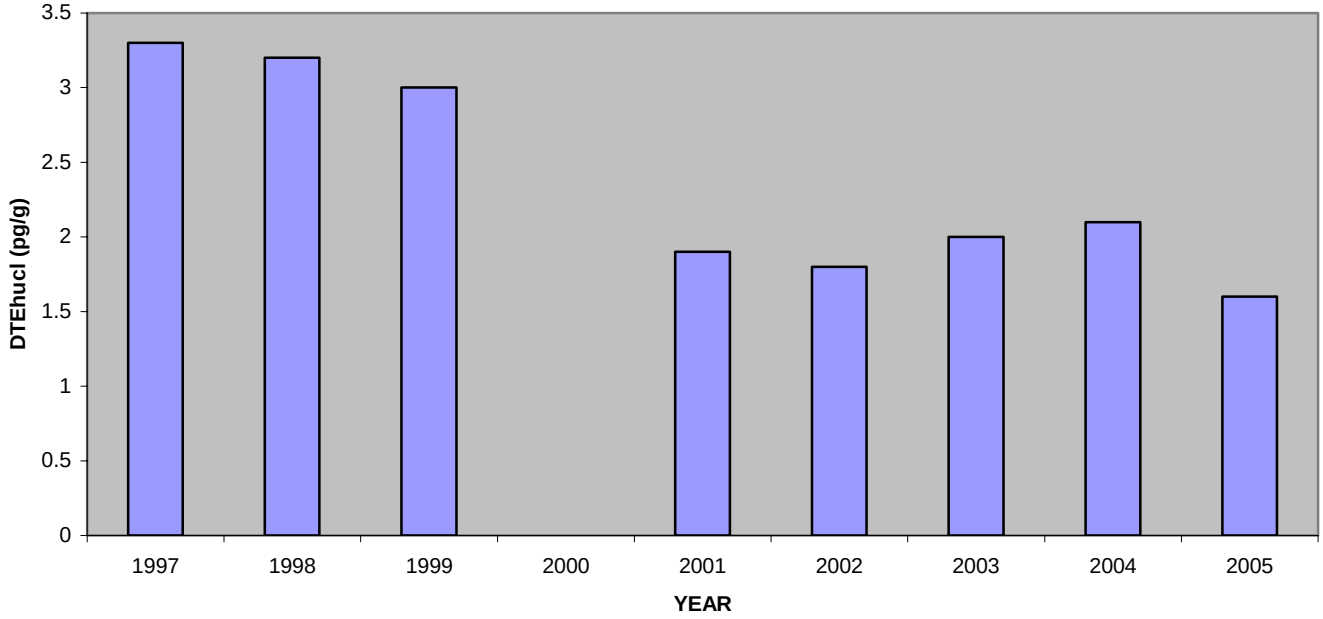
Given that this station is below NewPage Corporation's discharge with no known intervening discharges of dioxins, then the demonstration of continued compliance with the 1997 Dioxin Law discussed above for the Rumford station applies here as well.

Livermore Falls- (ALV) A total of 5 white suckers were captured in the Otis Impoundment approximately 2 miles downstream of the discharge from International Paper Company's Jay mill (Appendix 6).

Concentrations of DTEh in the suckers were 106% of the FTALc (Figures 1 and 2, Appendix 2). The addition of dioxin-like (coplanar) PCBs to DTEh results in total toxic equivalents (TTEh) that exceeds the FTALr .

There is a significant declining trend for TCDD and DTEh in suckers for the period 1997-2005 (Figure 6). Nevertheless, TCDD and DTEh are still significantly greater than reference stations on other Maine rivers (Appendix 7), likely the legacy of the long history of discharges. This fact warrants some continued monitoring, which can also be used to document continuing compliance with the no discharge provision.

Figure 6. Dioxin levels (DTEhucl) in white suckers from the Androscoggin River at Livermore Falls Maine



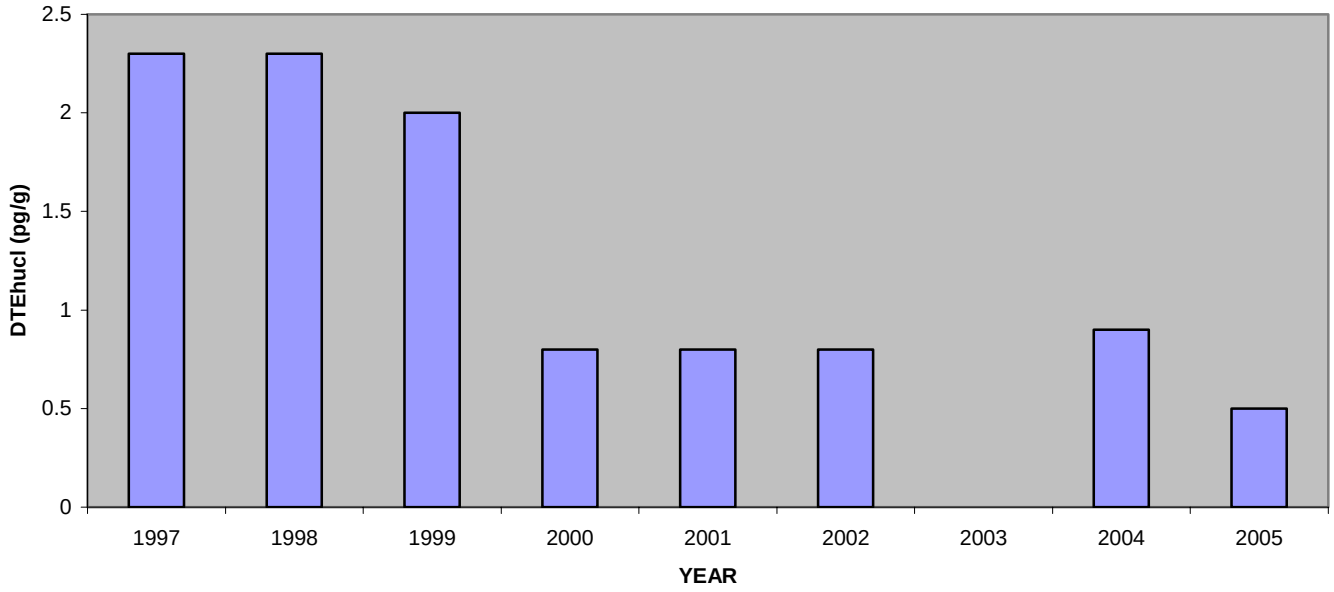
Fish sampling in 2003 and 2004 documented that the mill was no longer discharging measurable amounts of dioxins. In a letter dated December 19, 2005 the mill partially demonstrated continued compliance with the 'no discharge' provision of the 1997 Dioxin law by certifying that it has met the performance criteria established by DEP for the bleaching process and defoamer usage (Appendix 8). An annual sample of the bleach plant effluent will be analyzed for dioxins within 1 year of issuance of the Maine Pollution Discharge Elimination System permit in September 2005. Concentrations of both TCDD and TCDF have been reported below a 10 ppq detection limit in bleach plant effluent since 2002 up through 2004, the latest that data are available (Appendix 4). There are no new sludge data since 1996.

Auburn-GIP- (AGI) A total of 5 smallmouth bass were collected in Gulf Island Pond near the deep hole at Seagull Island, approximately 30 miles downstream of International Paper Company (Appendix 6). Concentrations of DTEh in the bass were 35% of the FTALc respectively but exceeded the pFTALc (Figure 1, Appendix 2). The addition of dioxin-like (coplanar) PCBs to DTEh results in higher levels of total toxic equivalents (TTEh) that do not exceed the FTALc.

There is a declining trend in TCDD and DTE in bass during the period 1997-2005 (Figure 7). TCDD and DTEh concentrations were still significantly greater than reference stations on other Maine rivers (Appendix 7), likely the legacy of the long history of discharges. As this station is a popular fishing spot, it warrants some continued monitoring for assessment of the Fish Consumption Advisories.

Given that this station is below International Paper Company's discharge with no known intervening ischarges of dioxins, then the demonstration of continued compliance with the 1997 Dioxin Law discussed above for the Livermore Falls station applies here as well.

Figure 7. Dioxin levels (DTEhucl) in smallmouth bass from the Androscoggin River at Gulf Island Pond, Auburn, Maine



Androscoggin Lake

Wayne- Androscoggin Lake in Wayne (ALW) and Leeds is a 4000-acre, 38-foot-deep meso-trophic lake with a unique reverse delta at the outlet formed by centuries of periodic backflow from the Androscoggin River via the Dead River into the lake. There is a dam on the Dead River that reduces, but does not prevent, the backflow into the lake, which usually occurs once or twice every year. Significant amounts of dioxin were found in fish from the lake beginning in 1996, but have been somewhat lower since.

In 2005, 10 smallmouth bass and 10 white perch were collected from the lake and analyzed as 2 composites of 5 fish each (Appendix 6). DTEh were 19%, and 56% of the FTALc for bass and white perch respectively, and DTEh in white perch exceeded the pFTALc (Figure 1, Appendix 2). The addition of dioxin-like (coplanar) PCBs to DTEh results in an increase in total toxic equivalents (TTEh) in these fish, causing concentrations in white perch to exceed the FTALr.

Concentrations in bass and white perch are generally lower in the recent years compared to when first monitored in 1996, although there is no trend in recent years (Figures 8 and 9). Concentrations of TCDD and DTEo in bass were no longer significantly greater than in game fish from all other lakes (n=8) or river reference stations that have been sampled but concentrations in white perch appear slightly higher. (Appendix 7). Concentrations in bass were similar to those in bass from AGI, the

nearest station on the river sampled in 2005, but concentrations in white perch were slightly higher than those for bass. Continued monitoring is needed.

Figure 8. Dioxin levels (DTEhucl) in smallmouth bass from Androscoggin Lake, Wayne, Maine

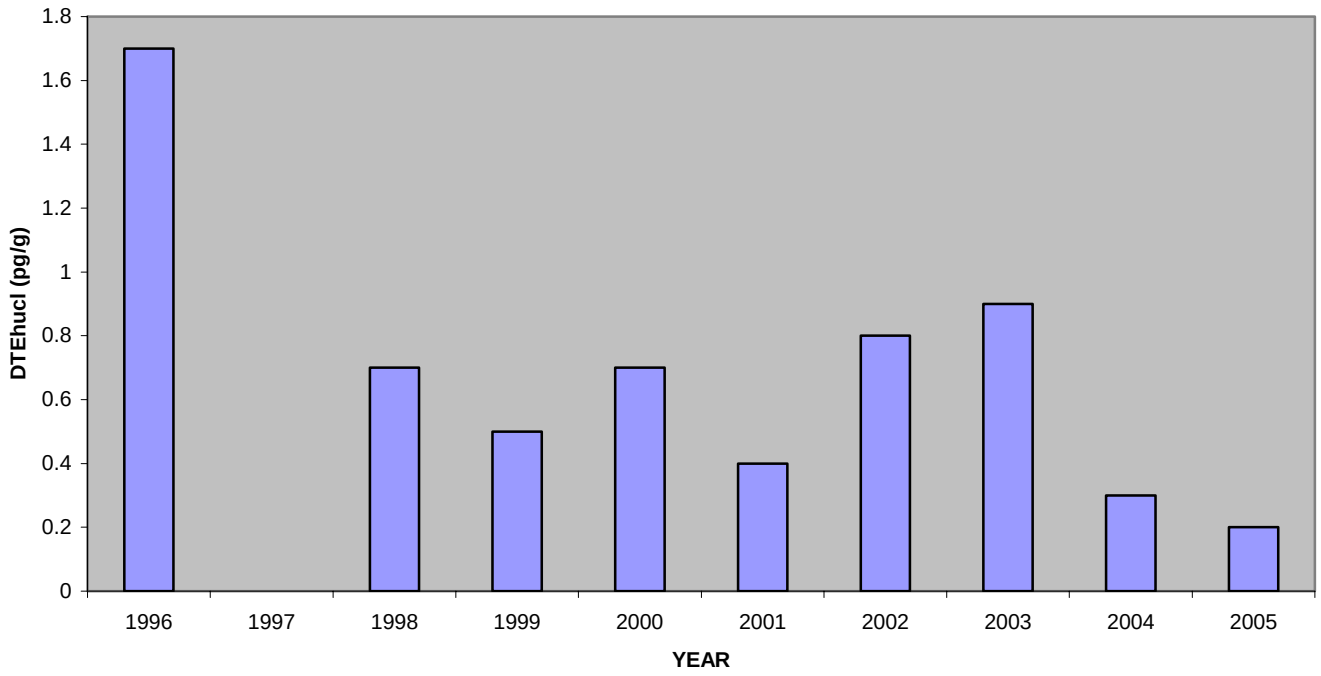
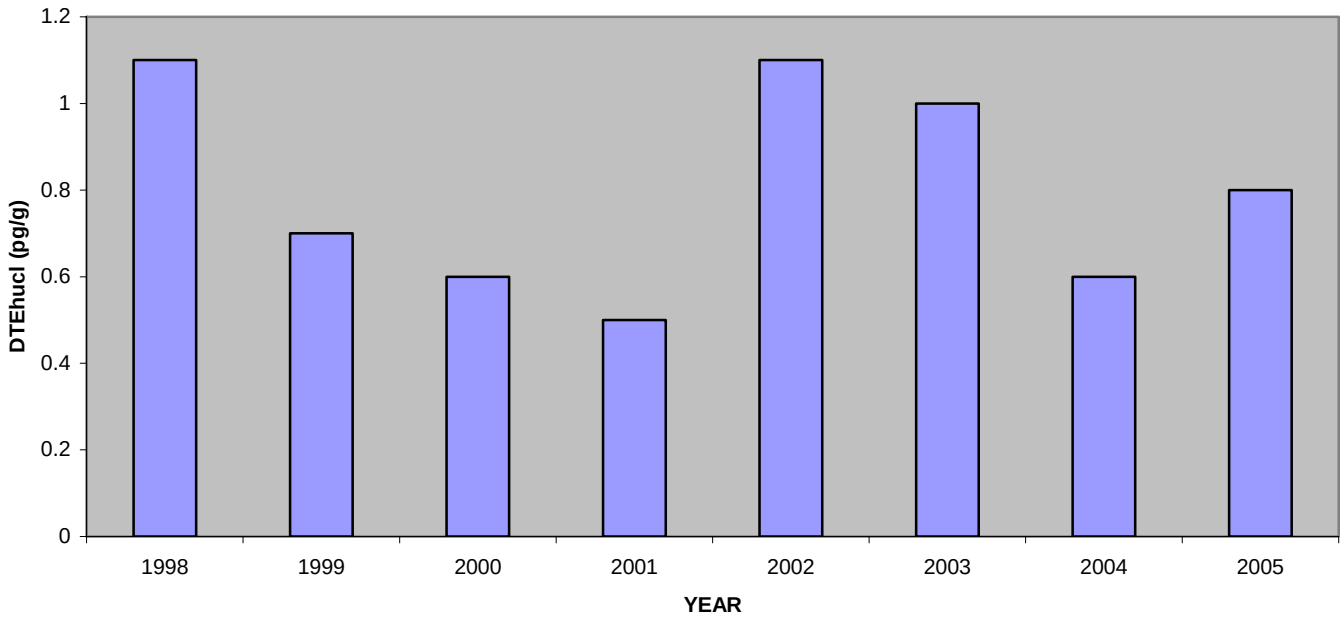


Figure 9. Dioxin levels (DTEhucl) in white perch from Androscoggin Lake, Wayne, Maine



Kennebec River

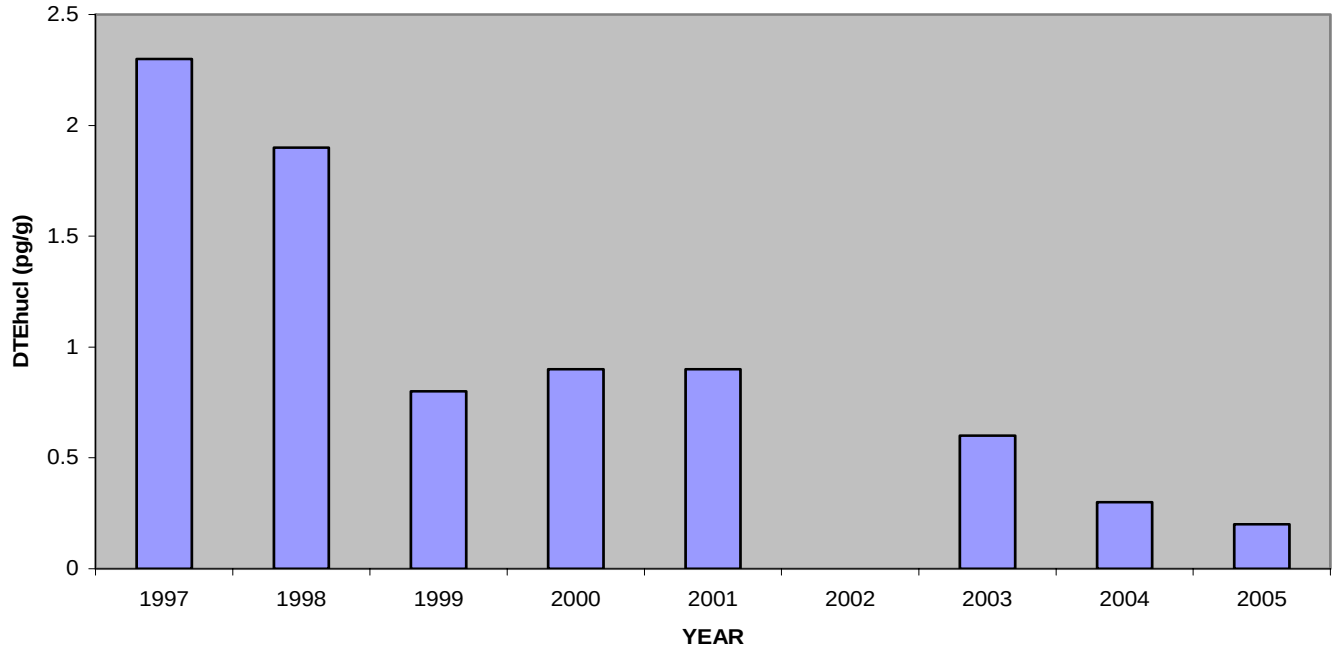
Fairfield- (KFF) A total of 4 brown trout and 5 white suckers were collected from the river between the Shawmut Dam and the I-95 bridge, approximately 7-8 miles below SAPPI Somerset's bleached kraft pulp and paper mill in Skowhegan (Appendix 6).

Concentrations of DTEh in trout and suckers were 10%, and 16% of the FTALc respectively and are below the pFTAL (Figures 1 and 2, Appendix 2). The addition of dioxin-like (coplanar) PCBs to DTEh results in an increase in total toxic equivalents (TTEh) that are below the FTALr but exceed the pFTAL.

There was a significant declining trend for TCDD and DTE for suckers for the period 1997-2005 (Figure 10). There are not enough data for trends analysis with brown trout, but concentrations in fish from 2002 and 2005 are significantly lower than those from the mid 1990s and 2001. Concentrations are similar to those of the reference station at Madison and Norridgewock from previous years.

Fish sampling in 2003 and 2004 documented that the mill was no longer discharging measurable amounts of dioxins. The mill has demonstrated continued compliance with the 'no discharge' provision of the 1997 Dioxin law. In a letter dated March 6, 2006 the mill certified that it has met the performance criteria established by DEP for the bleaching process and defoamer usage (Appendix 8). Sampling bleach plant effluent was conducted for the first half of 2005. Concentrations of both TCDD and TCDF have been reported below various low detection limits in bleach plant effluent since 2002 (Appendix 4). There are no new sludge data since 1999 (Appendix 3). Additional periodic monitoring should be continued to confirm low levels in brown trout and rainbow trout, which are fished heavily in this river reach.

Figure 10. Dioxin levels (DTEhucl) in white suckers from the Kennebec River at Fairfield, Maine



Penobscot River

Woodville (Mattaceunk Impoundment)- (PBM) A total of 30 smallmouth bass and 30 white suckers were collected from the river at Woodville, downstream of Katahdin Paper's pulp and paper mills in Millinocket and East Millinocket, and combined into 10 composites of 3 fish each. Fish collected at this station from 1997-2001 had similarly low concentrations of dioxin as the historical reference station at Grindstone on the East Branch, uninfluenced by any mill. Therefore, this station serves as a reference station for the Penobscot River and the upstream station for Lincoln Paper and Tissue above/below (A/B) test. Also as part of the A/B test, 5 cages of 20 mussels each were deployed at Winn below the confluence with the Mattawamkeag River about 8 miles above the mill discharge. Unfortunately, heavy fall rains and resulting flooding for months prevented retrieval of the mussels.

Concentrations of DTEh in bass and suckers were 10% and 38% of the FTALc respectively and in suckers exceeds the pFTAL (Figures 1 and 2, Appendix 2). The addition of dioxin-like (coplanar) PCBs to DTEh results in an increase in total toxic equivalents (TTEh) that is still below the FTALr.

Concentrations of TCDD and DTEh were similar to those of past years and at other reference stations for bass (Appendix 7). From 2002-2005, for 3 of 4 years DTE concentrations in suckers have been slightly higher that those historically at this station or at other reference stations. While there have been changes at the mills in Millinockett during this time, including purchasing of some kraft pulp for both mills, the amounts are relatively small and the timing is such that it is not clear where the increased DTE levels are originating. Additional sampling may be necessary in 2006.

South Lincoln- (PBL) A total of 30 smallmouth bass and 30 white suckers were collected from the river near the boat ramp in South Lincoln, approximately 4 miles downstream of Lincoln Paper and Tissue Company's bleached kraft mill in Lincoln and combined into 10 composites of 3 fish each for both species for the A/B test (Appendix 6). Also as part of the A/B test, 5 cages of 20 mussels each were deployed at the same site.

Concentrations of DTEh in bass and suckers were 12% and 22% of the FTALc respectively, below the pFTAL (Figures 1 and 2, Appendix 2). The addition of dioxin-like (coplanar) PCBs to DTEh results in an increase in total toxic equivalents (TTEh) that exceed the pFTAL for both species and the FTALr in suckers.

There were declining trends in DTE for both species (Figures 11 and 12) and for TCDD in suckers for the period 1997-2005. TCDD concentrations in bass are approaching levels seen at the reference station at Woodville but the declining trend was only marginally significant ($p\sim0.08$) for the period.

The mill passed the A/B test in 2003, but must pass in 2 consecutive years to ensure that there is no discharge of dioxin. The test was not conducted in 2004 since the mill had been closed for several months early in the year. In 2005, the test was repeated including deployment of caged mussels. Unfortunately, heavy fall rains and resulting flooding for months prevented retrieval of the mussels. The results of the fish samples show that there was no significant difference in the metric (DFTEh, dioxin/furan toxic equivalents at non-detects equaling one-half the detection limit) for white suckers above and below the mill. As reported by the lab, concentrations in smallmouth bass below the mill initially appeared to be slightly but significantly higher than in fish above the mill. The difference,

however, was due to different detection levels in fish above and below the mill. TCDD was not detected in any of the 10 samples upstream and in only 1 of 10 samples downstream, and that one was below the nominal detection limit and barely above the actual detection limit for the other samples where TCDD was not detected. Substitution of a common set of detection levels for all non-detects both above and below the mill resulted in no significant difference in the combined metric above and below the mill (Appendix 5). Furthermore, there was no significant difference in TCDF concentrations in fish above and below the mill providing assurance that there was in fact no difference. Consequently, the mill has passed the A/B test for the second year demonstrating that it no longer discharges significant amounts of dioxins.

Reduced discharge of dioxin from the mill has been documented by decreased concentrations of TCDD and TCDF in sludge (Appendix 3) and in effluent (Appendix 4) since a change in the mill's bleaching process from chlorine based bleaching to primarily oxygen based bleaching in 1999. These results are consistent with the declining trend seen in fish, and the finding of no significant discharge in 2005.

Figure 11. Dioxin levels (DTEhucl) in smallmouth bass from the Penobscot River at South Lincoln, Maine

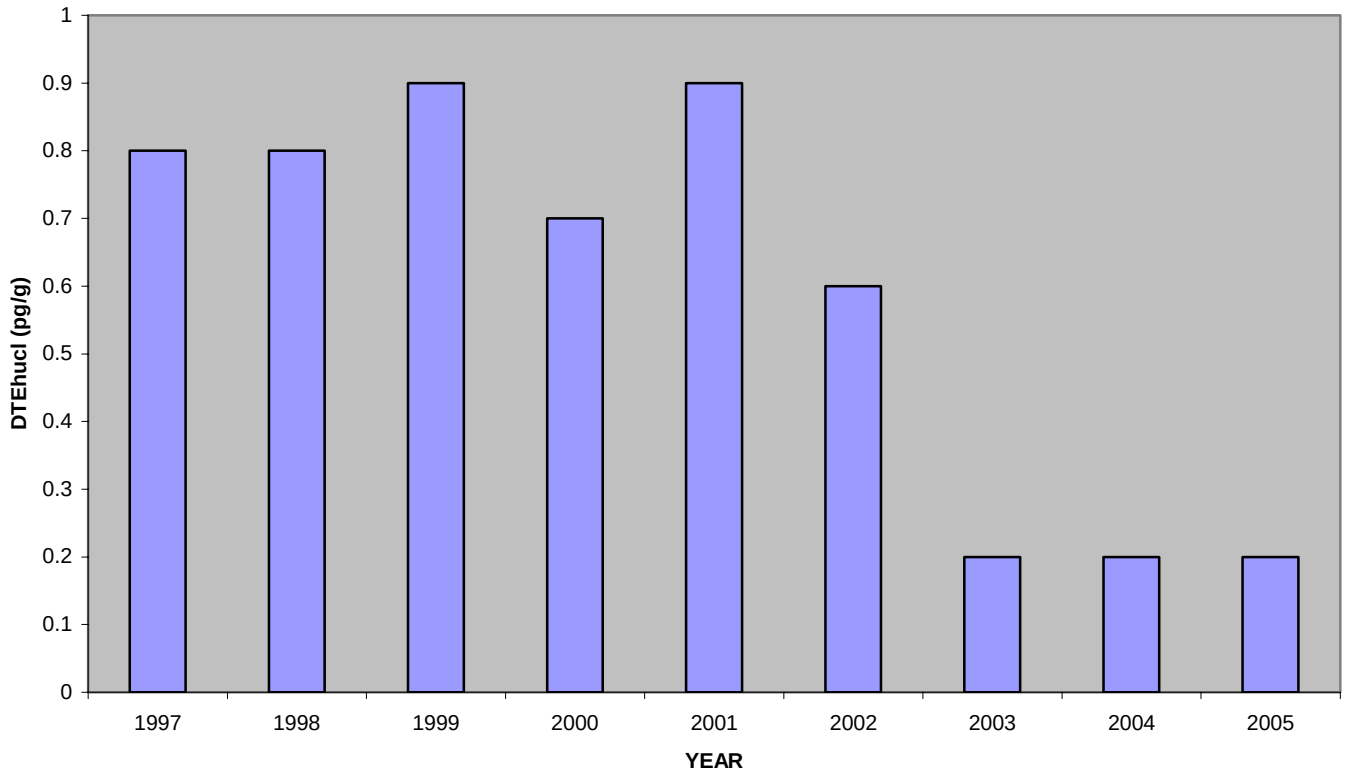
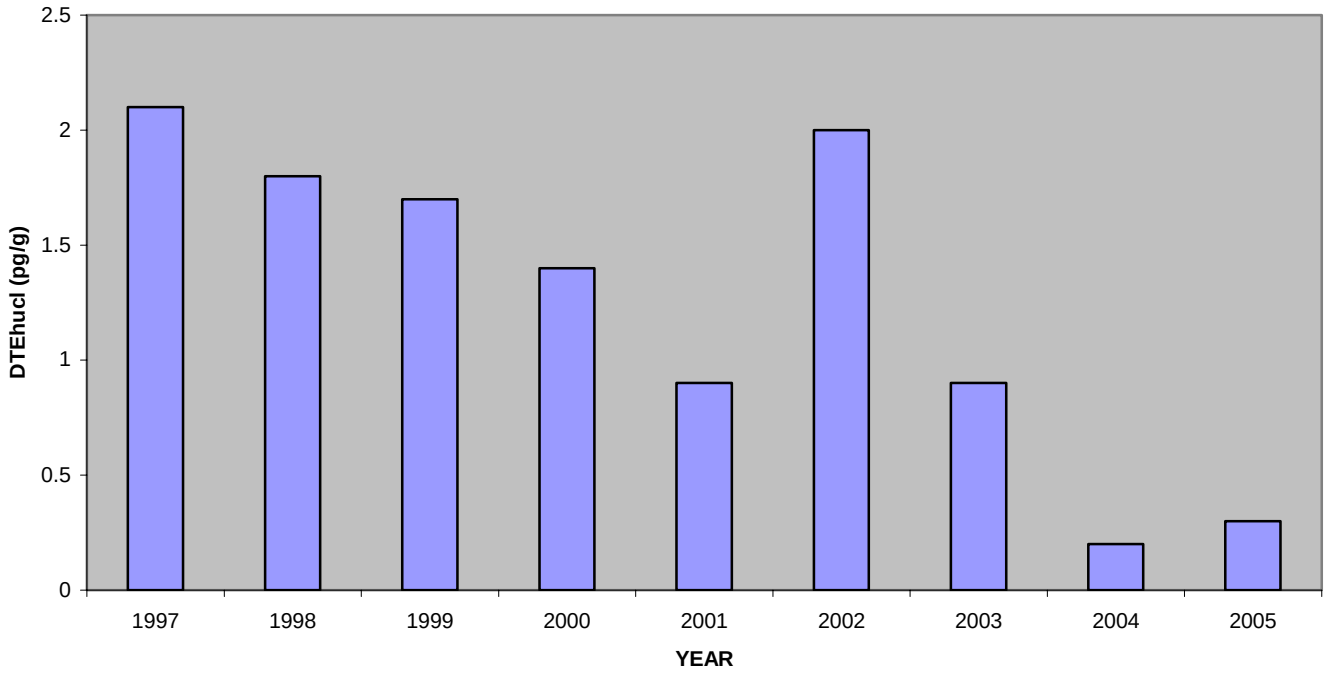


Figure 12. Dioxin levels (DTEhucl) in white suckers from the Penobscot River at South Lincoln, Maine



Veazie- (PBV) A total of 5 smallmouth bass and 5 white suckers (Appendix 7) were collected from the Veazie Impoundment about 7-8 miles below Fort James' bleached kraft mill in Old Town (Appendix 6). The smallmouth bass were substituted for the eels, called for in the 2005 workplan and which were not collected.

Concentrations of DTEh in bass and suckers were 14% and 33% of the FTALc respectively and were below the pFTAL in bass but above it in suckers (Figures1 and 2), Appendix 2). The addition of dioxin-like (coplanar) PCBs to DTEh results in an increase in total toxic equivalents (TTEh) but that is still below the FTALr.

There was a declining trend for TCDD for both species for the period 1997-2005, but there was only a marginal (p~0.09) decline in DTEh (Figures 13 and 14). This is a bit surprising since TCDD and TCDF bleach plant effluent concentrations at the Georgia Pacific mill have continued to decline since early 1998 and remain below suitably low detection levels (Appendix 4).

The 2003 and 2004 A/B tests had documented that there was no longer a discharge of dioxin from the mill. Continued compliance in 2005 was documented by low or non-detected concentrations in bleach plant effluent (Appendix 4). Additional periodic monitoring and certification of bleach plant operation will be necessary to confirm continued reduced concentrations.

Figure 13. Dioxin levels (DTEhucl) in smallmouth bass from the Penobscot River at Veazie

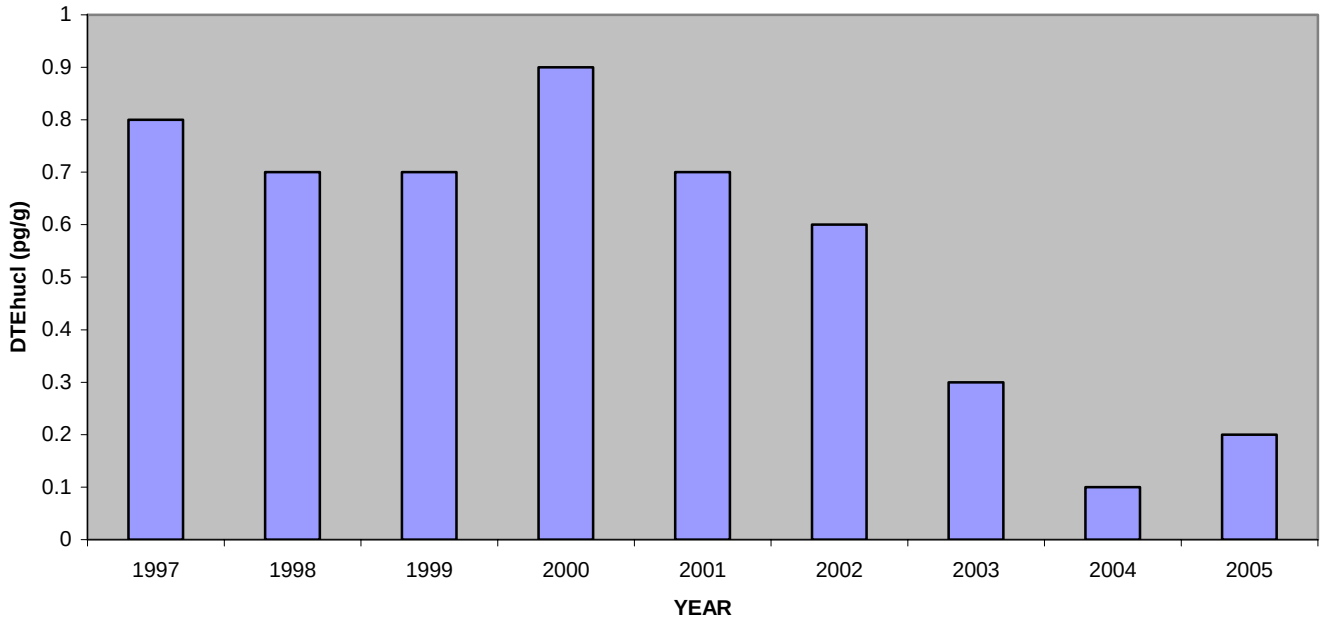
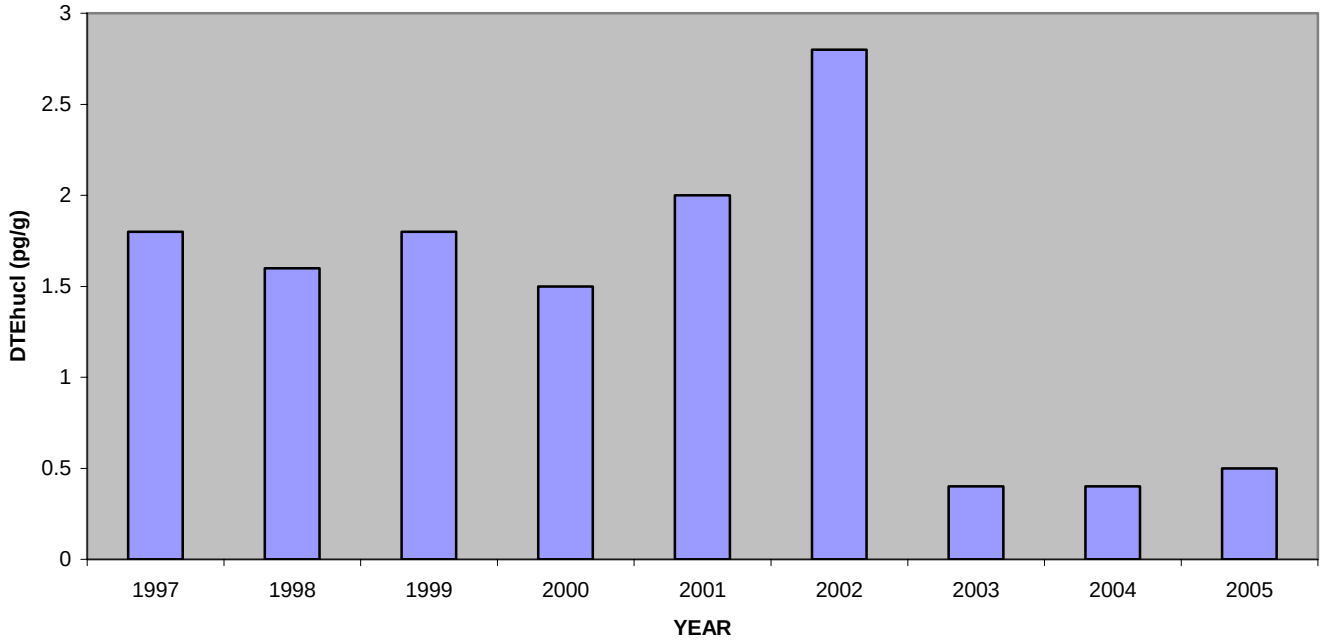


Figure 14. Dioxin levels (DTEhucl) in white suckers from the Penobscot River at Veazie, Maine



Salmon Falls River

There is currently a fish consumption advisory on the Salmon Falls River below Berwick due to a combination of dioxins and PCBs. Up through 2002, fish samples have been collected from the Salmon Falls River about 2 miles below the discharge from the Berwick Sewer District's municipal wastewater treatment plant in Berwick, whose discharge is 85% effluent from Prime Tanning Company, in order to document current status of fish for assessment of the fish consumption advisory and any trends in the discharges. Sampling was scheduled for 2003 and 2004 but fish were not captured. DEP's long standing policy has been that where there is a single discharger of dioxin in a river, fish sampling is the best way to determine the status of any discharge. Where there is more than one source, sampling of sludge may be used to determine discharge status. Prime Tanning Company notified DEP that there was an additional source historically in Somersworth NH. Consequently, after discussion with the New Hampshire Department of Environmental Services, testing of both Berwick and Somersworth, NH wastewater treatment plant sludge was substituted for fish testing on a quarterly basis. The results of the first two quarters' sampling show that concentrations from both are relatively low and similar to those from the Town of Hartland and Irving Tanning below which are significantly elevated concentrations in fish (Appendix 3). Samples will be collected in then next two quarters before a decision is made regqarding further action.

Sebasticook River

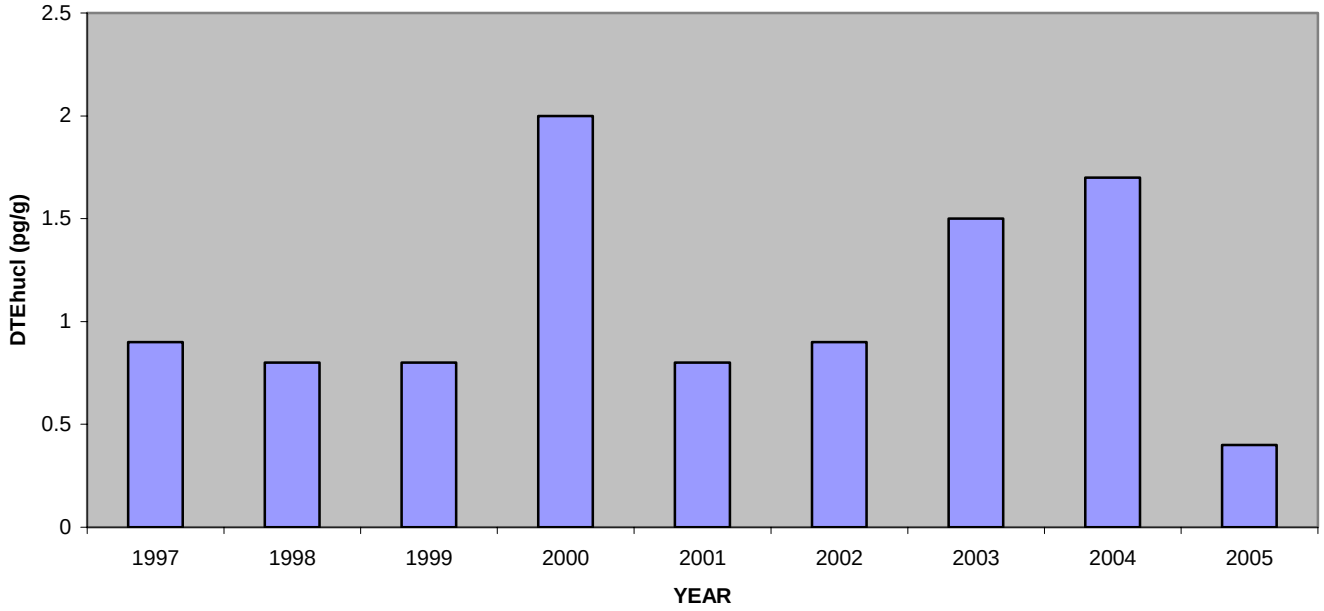
West Branch at Palmyra (SWP) A total of 5 smallmouth bass were collected from the river near the US Route 2 bridge about 3-4 miles below the discharge from the Town of Hartland, whose effluent is about 85% effluent from Irving Tanning Company (Appendix 6).

Concentrations of DTEh were 26% of the FTALc and right at the pFTAL (Figure 1, Appendix 2). The addition of dioxin-like (coplanar) PCBs to DTEh results in total toxic equivalents (TTEh) that exceed the pFTAL but are well below the FTALr. Concentrations are still higher than those from the upstream reference station in previous years or from other reference stations in Maine.

Concentrations were also much lower than in previous years, but still higher than those following the pattern of the past few years, with wide variation from one year to the next (Appendix 7). Consequently, there is no declining trend (Figure 15). As this station is heavily fished, continued monitoring is warranted.

These results document a current or historical local source of dioxin to this reach of the river, most likely the Irving Tanning discharge. Although the only effluent sample result reported (1996) showed no detectable amount of dioxin in effluent (Appendix 4), low solubility and high bioconcentration of dioxin make effluent data less meaningful than sludge data. Sludge data from 1989 show measurable levels of TCDF (Appendix 3), but more recent data in 2000 show concentrations below reasonably low detection levels. If these recent data are representative of reduced discharges, concentrations in fish should decrease in time, the length of which will be determined by how much residual dioxin remains in the system.

Figure 15. Dioxin levels (DTEhucl) in smallmouth bass from the West Branch Sebasticook River at Palmyra, Maine



Burnham- (SEB) A total of 5 smallmouth bass were collected from the main stem of the Sebasticook River after the confluence of the East Branch and West Branch (Appendix 6) at the request of the Maine Center for Disease Control and Prevention (formerly the Maine Bureau of Health) as part of Maine's Surface Water Ambient Toxics (SWAT) monitoring program. This reach, then, receives water from upstream sources from SEN (not sampled in 2005) and SWP. Results are reported here for ease of comparison with other dioxin data.

Concentrations of DTEh were 29 % of the FTALc and exceeded the pFTALc (Figure 1, Appendix 2). TCDD levels were elevated above those of reference stations likely reflecting the effect of the upstream sources. Concentrations were slightly lower than those in 2004 similar to those at SWP. The addition of dioxin-like (coplanar) PCBs to DTEh results in total toxic equivalents (TTEh) that are higher but still below the FTALr.

References

Applied Biomontoring, 2004. Final report, 2003 Kennebec River caged mussel study, submitted to Friends of Merrymeeting Bay, Richmond, Me. 71 pp.

APPENDIX 1.

FISH CONSUMPTION ADVISORIES

APPENDIX 2A.

SPECIES AND STATION CODES

SPECIES CODES

BNT	brown trout
EEL	eel
LMB	largemouth bass
RBT	rainbow trout
SMB	smallmouth bass
WHP	white perch
WHS	white sucker

STATION CODES

AGL	Androscoggin R at Gilead above NewPage
ARP	Androscoggin R at Rumford Point above NewPage
ARF	Androscoggin R below Rumford below NewPage
ARY	Androscoggin R at Riley above International Paper
ALV	Androscoggin R at Livermore Falls below International Paper
AGI	Androscoggin R at Gulf Island Pond, Auburn below International Paper
ALS	Androscoggin R at Lisbon Falls below International Paper
ALW	Androscoggin Lake at Wayne below International Paper
KRM	Kennebec R at Madison above SAPPI Somerset, Skowhegan
KNW	Kennebec R at Norridgewock above SAPPI Somerset, Skowhegan
KHY	Kennebec R at Hinckley, above SAPPI Somerset Skowhegan
KFF	Kennebec R at Shawmut, Fairfield below SAPPI Somerset, Skowhegan
KRS	Kennebec R at Sidney below SAPPI-Somerset & KSTD in Waterville
PBW	Penobscot R at Woodville above Lincoln Paper & Tissue
PBM	Penobscot R at Winn above Lincoln Pulp and Paper in Lincoln
PBL	Penobscot R at S Lincoln below Lincoln Pulp and Paper in Lincoln
PBC	Penobscot R at Costigan, Milford above Georgia Pacific in Old Town
PBV	Penobscot R at Veazie below Georgia Pacific in Old Town
PBO	Penobscot R at Orrington below Georgia Pacific in Old Town
PWD	Presumpscot R at Windham above SAPPI Westbrook
PWB	Presumpscot R at Westbrook below SAPPI Westbrook
SFS	Salmon Falls R at S. Berwick below Berwick POTW and Prime Tanning
SEN	E Br Sebasticook at Newport below Corinna and former Eastland Woolen mill
SED	E Br Sebasticook at Detroit below Corinna and former Eastland Woolen mill
SWP	W Br Sebasticook at Palmyra below Hartland POTW and Irving Tanning

APPENDIX 2.

DIOXIN AND FURAN CONCENTRATIONS IN 2004 FISH AND SHELLFISH SAMPLES

APPENDIX 3.

TCDD & TCDF IN SLUDGE FROM MAINE WASTEWATER TREATMENT PLANTS

APPENDIX 4.

TCDD & TCDF IN WASTEWATER FROM MAINE PULP AND PAPER MILLS

APPENDIX 5.

TCDD, TCDF, AND P-VALUES FOR 2005 A/B TEST

APPENDIX 6.

LENGTHS AND WEIGHTS FOR 2004 FISH SAMPLES

APPENDIX 7.

SUMMARY OF DIOXINS AND FURANS IN FISH AND SHELLFISH SAMPLES, 1984-2004

APPENDIX 8

CERTIFICATIONS OF BLEACH PLANT OPERATION